Aug. 15, 1944. C. E. PECK 2,356,084

GAS-GENERATOR UNIT

Filed March 16, 1940 2 Sheets-Sheet 1

Fig. 1.

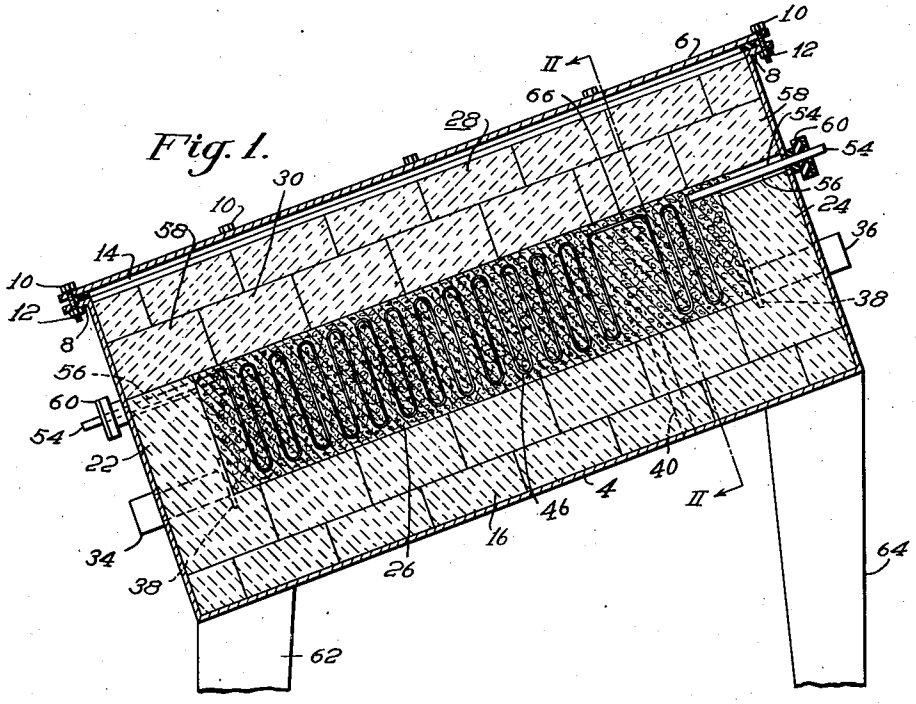
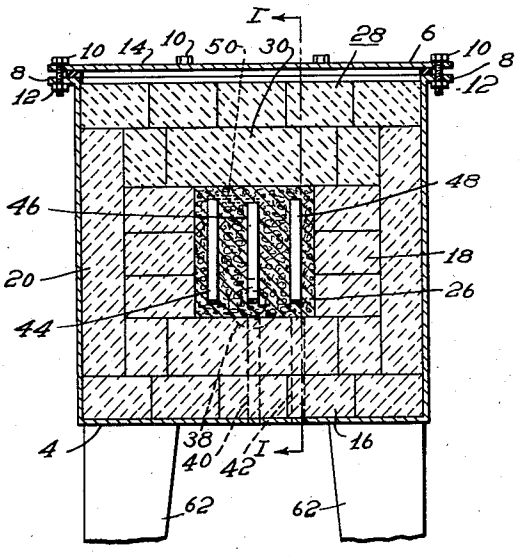


Fig. 2.



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Fig. 5.

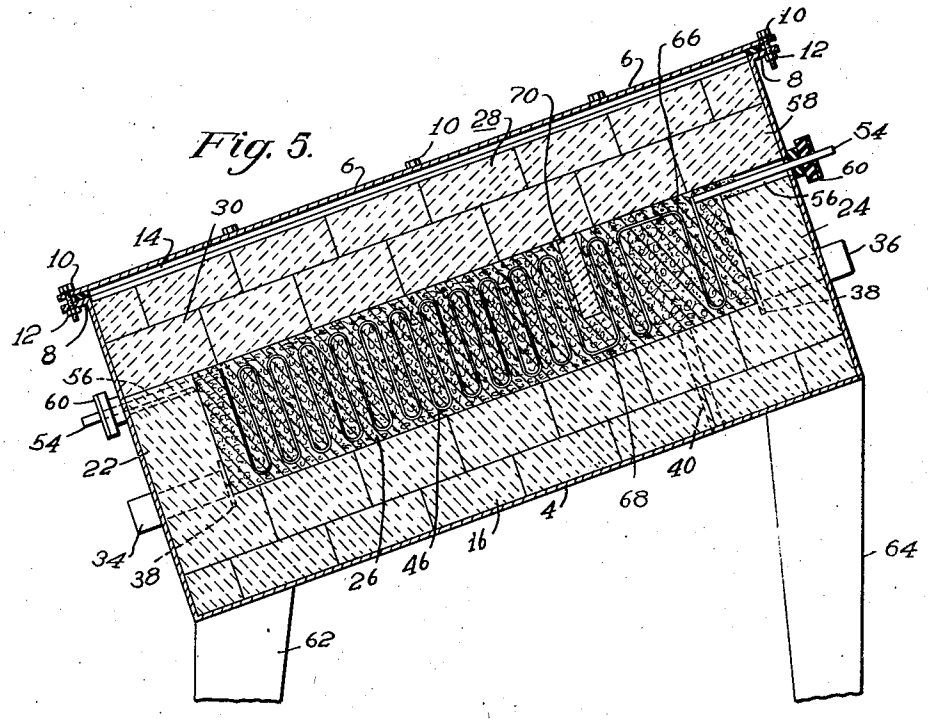


Fig. 3.

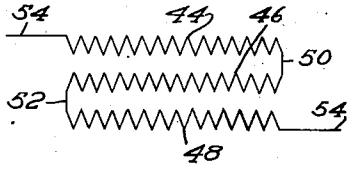
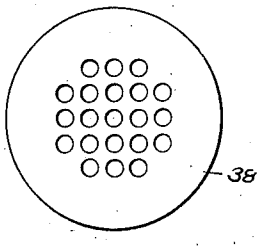


Fig. 4.



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UNITED STATES PATENT OFFICE

2,356,084

GAS-GENERATOR UNIT

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Application March 16, 1940, Serial No. 324,410

4 Claims. (Cl. 23—281)

This invention relates generally to an improved gas-generator in which combustible hydrocarbon gases may be reacted with oxygen-containing gases, such as air, for obtaining a controlled or protective atmosphere suitable for enveloping a charge, usually metallic, which is undergoing a heat-treatment in a suitable furnace, which atmosphere will have the desired constituents even over long periods of time.

My invention relates more particularly to that type of generator in which the combustible hydrocarbon gas, which may be commercially available manufactured gas, natural gas, or other similar hydrocarbon gases, is endothermally reacted with air to obtain a product-gas which is rich in hydrogen and carbon monoxide but which has very small amounts of carbon dioxide and negligible amounts of water vapor and methane.

To obtain gases which will protect the metal being heat-treated against scaling, or against decarbonization or other undesired chemical change, if the metal be a steel, the gas-generator must be efficient in promoting the required reactions between the combustible gas and air. The efficiency of the gas-generator is manifested by the amount of residual methane in the outgoing gas-product. For very low air-to-gas ratios such as required in short-cycle heat-treatment of high carbon and alloy carbon steels, the amount of residual methane may be as much as several per cent if the gases are not completely reacted.

In order to assure an adequate control of the outgoing gas-product of the generator, the generator is filled with a catalyst, and an electric heating unit is embedded in the catalyst for supplying the heat for promoting the desired reactions.

It is an object of my invention to provide a gas-generator in which the electric heating element or elements are suitably embedded and completely distributed throughout the catalyst so that the catalyst is uniformly heated throughout. A temperature responsive means may be utilized for controlling the amount of electrical energy supplied to the heating element or elements so that the catalyst will be maintained at the proper reaction temperature.

In accordance with my invention the gas-generator is made relatively long horizontally as compared to its height, so that the gases to be reacted must flow through a relatively long path. This construction has the further advantage that I am able to readily insert or remove the heating element or elements in the generator by making the top wall removable.

An additional improvement feature of my invention lies in the slight tilting of the gas-generator so that its gas-discharge end is somewhat above the gas-inlet end. This slight tilt reduces the effects of channeling by settling of the catalyst, by channeling meaning the creation of a void or space between the top wall of the generator and the upper surface of the settled catalyst, through which gases might freely flow without being thoroughly reacted. Tilting of the generator does not, of course, prevent settling of the catalyst but it does cause the settling to be such that the major portion of the gas-generator is at all times compactly filled with the catalyst, the spaces due to settling occuring in the upper corner of the generator. In this way, I make it unnecessary to use baffles across the top chamber, although, if desired, one or two baffles may be added as a further precaution.

It is a purpose of my invention to provide a compact gas-generator having a high efficiency, and a high capacity for its size.

Features and objects of my invention not mentioned above will be apparent from the following description thereof, which is to be taken in conjunction with the attached drawings, in which:

Figure 1 is a vertical longitudinal cross-sectional view of my novel gas-generator taken on the line I—I of Fig. 2;

Fig. 2 is a vertical transverse cross-sectional view of the generator taken on the line II—II of Fig. 1;

Fig. 3 is a symbolic wiring diagram showing one manner in which three resistor units in the gas-generator may be connected.

Fig. 4 is an enlarged elevational view of a distribution diaphragm at the inlet and outlet openings of the gas-generator; and

Fig. 5 is a view similar to Fig. 1, of a slightly modified form of gas-generator.

The gas-generators of the preferred forms of my invention are adapted for general horizontal disposition, that is, the gas-generator has a reaction chamber which is relatively long horizontally, with the gas flowing therethrough in a generally horizontal direction. Referring to the embodiment shown in Fig. 1, the generator comprises a metallic outer shell which is made substantially gas-tight, as is customary in the art. This shell comprises a lower box-like portion 4 covered by a removable top 6 adapted to be secured to flanges 8 defining the upper periphery

at the top of the shell-box 4. The top is secured to the flanges 8 by means of a plurality of bolts 10 and nuts 12. A gasket 14 is interposed between the top 6 and the flanges 8 so that by suitable clamping pressure due to the bolts and nuts, the top is secured relatively gas-tightly to the shell-box 4.

The generator further comprises a refractory and insulating bottom wall 16 laid along the bottom of the shell-box 4, and similar side walls 18 and 20, and end walls 22 and 24 also laid inside the shell-box 4, the walls defining a reaction chamber 26 whose top is defined by a refractory-tile top wall 28.

As indicated by the different cross hatchings in Figs. 1 and 2, the top wall 28 comprises dry-laid removable tile having bridging blocks 30 extending across the reaction chamber 26 and resting on the side walls 18 and 20. Above the removable blocks 30 are additional dry-laid blocks, preferably heat insulators, which are also readily removable so that access may be had to the reaction chamber 26 by first removing the top 6 from the shell-box 4, and then removing the loose dry-laid blocks forming the top wall which extends from one end of the generator to the other.

The gases to be reacted in the reaction chamber 26 may be conveyed in proper proportions to the generator by any suitable apparatus including mixing devices, many of which are known to those skilled in the art. The end wall 22 is provided with a suitable opening for the admission of a mixture of combustible hydrocarbon gas and air through a nozzle, indicated schematically at 34, which may be relatively gas-tightly secured to the shell-box. The other end wall 24 of the generator is provided with an outlet discharge passage for the gaseous products of reaction, a suitable outlet pipe, indicated schematically at 36, being substantially gas-tightly secured around an aperture in the corresponding end of the shell-box, to which a pipe system may be connected for conveying the gas away from the generator. The passages in the end walls 22 and 24 terminate in apertured distribution plates 38 embedded in the walls at the reaction chamber sides.

The bottom of the generator is provided with a plurality of holes 40 and 42 through the shell box and bottom wall through which may be passed a suitable thermocouple means connected to apparatus for controlling the electrical energy supplied to the electrical heating elements to be subsequently described, and a fuse for protecting these elements, these control and protective devices being suitably secured gas-tightly to the outside of the bottom of the shell-box 4.

The reaction chamber 26 is filled with a divided catalyst in the nature of activated alumina impregnated with nickel formate, the pieces ranging in size up to about an inch or 1½ inches, or somewhat more for generators of 500 to 2000 cubic feet per hour capacity, and greater for larger generators. Disposed in the reaction chamber and embedded in the catalyst in direct contact therewith is the heating means comprising, in this instance, three heating elements 44, 46 and 48, each of which extends substantially the full length of the reaction chamber, and has relatively compact convolutions with return bends near the bottom and top walls of the generator. As may be observed from Fig. 2, the three heating elements are distributed across the width of the chamber 26, being spaced from each other so that the catalyst in the reaction chamber is fairly uniformly heated throughout.

The heating elements are connected in series, one end of the heating element 44 being connected to an adjacent end of the heating element 46 by cross bars 50 inside the reaction chamber, and the opposite end of the element 46 being connected to an adjacent end of the element 48 by a like cross bar 52, the cross bars being near the respective end walls of the generator.

The free ends of the heating elements 44 and 48 are provided with terminals 54 which are disposed in cavities 56 formed in the end walls 22 and 24 at their top portions, the cavities being covered by removable, dry-laid top wall blocks 58 when the top wall tile is placed in position during the assembly of the generator. The terminals extend through the outer metallic shell and suitable terminal outlets 60 may be used to insulate and fix the position of these terminals, and to gas-tightly cover the apertures in the metallic shell through which the terminals pass. Any conventional terminal outlet may be utilized but I prefer to use terminal outlets such as shown in the P. G. Lessmann Patent No. 2,200,115, granted May 7, 1940, and assigned to the Westinghouse Electric & Manufacturing Company.

The generator is preferably supported by a four-legged supporting framework having front legs 62 and rear legs 64, the legs being so proportioned that the gas-inlet end of the generator is below the gas-outlet end of the generator, the height being such that the generator is disposed at an angle of about 20° to the horizontal. Although this angle may be varied, it should not be so large as to increase the difficulties of the assembly of the generator.

In assembling the generator the bottom wall 16, side walls 18 and 20, and end walls 22 and 24 are built into the inside of the shell-box 4 with the walls being provided with the passage holes and cavities previously described, and such additional holes as may be required for the reception of any other apparatus, or to provide a peep-hole which is sometimes desirable. The plates 38 are also set in place during the assembly of the walls. After the aforesaid walls are completed, a layer of the catalyst is laid along the bottom of the heating chamber 26, after which the heating elements 44, 46 and 48 are placed in the chamber, the terminals 54 resting in the cavities 56 and passing through holes in the shell. In putting the heating elements in place, one terminal is first passed through the proper hole in one end of the shell, and the heating element having the other terminal is slightly deformed or compressed to permit the other terminal to pass through the hole in the other end of the shell. The bottom return bends of the heating elements are suitably rested on the bottom layer of the catalyst, and then the remainder of the catalyst may be placed in the chamber, being packed down and around the individual turns of the heating elements.

I prefer to pack the catalyst from the bottom at the left of Fig. 1 upwardly, and as the chamber 26 becomes filled to place the removable tile of the top wall in position, one after the other, as the filling of the chamber progresses to the right so that the catalyst can be properly packed in the reaction chamber 26. After the reaction chamber has been filled with catalyst and the last tile 58 placed in position, the remainder of

the top wall may be built up and the top 6 secured to the shell-box 4, completing the pertinent part of the assembly relating to my invention.

Because of the direct contact of the heating elements with the catalytic mass in the reaction chamber and the large contact area provided between the resistor units and the catalyst, I am able to very accurately control the temperature of the gas-reaction chamber for the endothermic reaction of rich mixtures of combustible hydrocarbons and air. The gases reacted in my generator, and the product gases are similar to those described in the John R. Gier, Jr., application, Serial No. 270,873, filed April 29, 1939, patented March 18, 1941, No. 2,235,401, and assigned to the Westinghouse Electric & Manufacturing Company, which shows a vertical gas-generator having a helical heating unit embedded in the catalyst. However, for a compact generator, adapted for the higher output capacities, which can be easily built and serviced, and which can be operated at high efficiencies, the gas-generator of this disclosure has certain desirable features. The generator can be operated with the proportions of the constituents of the product gases maintained within very narrow limits over extended periods of time.

The tilting of the generator I consider to be an important improvement for obtaining a gas-product of consistent composition with continual use of the generator over extensive periods, the tilting nullifying the effect of the settling of the catalyst, which would otherwise produce channels between the top wall and the top of the catalytic mass, through which gases might quickly flow without thorough reaction. Any settling that does occur tends to drive the pieces of catalyst into the lower parts of the generator so that any voids or spaces created will be confined to the upper corner of the reaction chamber. The use of baffles to counteract channeling is avoided.

It may be observed that the heating elements are provided with an extra wide convolution 66 which is aligned with the holes 40 and 42. This enables the thermo-couple and fuse to be disposed properly inside the reaction chamber out of contact with the heating elements. I have found it necessary to provide such a larger convolution only in the heating elements which are close to the thermo-couple pipe or fuse, in this case, the heating elements 46 and 48.

In Fig. 5, I show an additional wider convolution 68 which is formed in all of the heating elements so that a baffle 70, supported on the side walls of the furnace, may be provided near the top of the gas chamber as a further precaution against channeling, in cases where the catalyst is not so densely packed as might be the case when the angle of tilt is smaller, although the baffle 70 can be dispensed with in most instances.

In accordance with the objects of my invention, I have provided a gas-generator which is simple to construct and in which heating elements can be very easily replaced. Moreover, the features of invention adapt themselves to gas-generators of different sizes, thereby reducing the number of parts required for producing a range of sizes of gas-generators, since for larger capacities it is merely necessary to provide a wider reaction chamber, or to vary the cross-sectional size of the chamber to suit the gas-output required; but, in general, however, I prefer to keep the height of the reaction chamber relatively small so that the heating elements can be easily assembled in the generator in complete contact with the catalytic mass. It is quite obvious that the number of heating elements to be utilized can be varied, and that for a wider reaction chamber more than three rows of elements can be used, while for a relatively narrow chamber, less than three would be preferred, the important object being to keep the catalytic mass completely heated throughout and uniformly so, achieved, in accordance with my invention, by distributing the heating elements through the catalyst.

While I have shown my invention in embodiments which I believe to be now preferred, it is obvious that many equivalents may be used, and changes made, within the spirit of my invention.

I claim as my invention:

1. A structure of a class described in which hydrocarbon gases can be reacted with oxygen-containing gases, such as air, in the presence of a catalyst for producing a product-gas useful in metal heat-treating, comprising: a gas-generator having non-metallic refractory walls defining an elongated sloping but generally horizontal reaction chamber having a length considerably in excess of its height, said walls including a top wall lengthwise of said reaction-chamber and spaced upright side walls, said top wall comprising readily removable tile over the reaction-chamber, including blocks individually spanning the reaction-chamber and supported by said spaced upright side walls, an outer gas-tight metallic casing for said walls, said casing including a detachably-secured top-portion over said readily removable tile, gas-inlet means at one end of said reaction chamber, gas-outlet means at the other end of said reaction chamber, electric heating-means distributed in said reaction-chamber, and a removable bed of a divided gas-pervious catalyst substantially filling the remainder of said reaction chamber.

2. A structure of a class described in which hydrocarbon gases can be reacted with oxygen-containing gases, such as air, in the presence of a catalyst for producing a product-gas useful in metal heat-treating, comprising: a gas-generator having non-metallic refractory walls defining an elongated sloping but generally horizontal reaction chamber having a length considerably in excess of its height, said walls including a top wall lengthwise of said reaction-chamber and spaced upright side walls, said top wall comprising readily removable tile over the reaction-chamber including blocks individually spanning the reaction-chamber and supported by said spaced upright side walls, an outer gas-tight metallic casing for said walls, said casing including a detachably-secured top-portion over said readily removable tile, gas-inlet means at one end of said reaction chamber, gas-outlet means at the other end of said reaction-chamber, electric heating-means comprising a plurality of substantially flat convoluted metallic resistor elements extending lengthwise, in spaced relation, in said reaction-chamber, and a removable bed of a divided gas-pervious catalyst substantially filling the remainder of said reaction-chamber, with said resistor-elements substantially embedded therein.

3. A structure of a class described in which hydrocarbon gases can be reacted with oxygen-containing gases, such as air, in the presence of a catalyst for producing a product-gas useful in metal heat-treating, comprising: a gas-generator having non-metallic refractory walls defining

an elongated reaction chamber having a length considerably in excess of its height, said walls including a top wall lengthwise of said reaction-chamber and spaced upright side and end walls, said top wall comprising readily removable tile over the reaction-chamber including blocks individually spanning the reaction-chamber and supported by said spaced upright side walls, an outer gas-tight metallic casing for said walls, said casing including a detachably-secured top-portion over said readily removable tile, gas-inlet means at one end of said reaction-chamber, gas-outlet means at the other end of said reaction-chamber, a removable divided gas-pervious catalyst substantially filling said reaction-chamber, and electric heating-means comprising resistor means in said catalyst having a connector-terminal in an open cavity across the top of one of said upright walls, said cavity being coverable by said removable tile of said top wall.

4. A structure of a class described in which hydrocarbon gases can be reacted with oxygen-containing gases, such as air, in the presence of a catalyst for producing a product-gas useful in metal heat-treating, comprising: a rectangular gas-generator having non-metallic refractory walls defining an elongated sloping but generally horizontal reaction chamber having a length considerable in excess of a transverse dimension, said walls including a first wall lengthwise covering an elongated side of said reaction chamber and spaced upright end walls, said first wall comprising readily removable tile substantially coextensive with said elongated side, said first wall being substantially perpendicular to the direction of said transverse dimension, an outer gas-tight metallic casing for said refractory walls, said casing including a detachably-secured portion juxtaposed to and substantially coextensive with said removable tile, gas-inlet means and gas-outlet means, respectively passing through said spaced end walls, for delivering and withdrawing gases, respectively, from opposite ends of said reaction chamber, a plurality of electrical resistor heating-elements distributed in spaced relation in said reaction chamber, and a removable bed of a divided gas-pervious catalyst substantially filling the remainder of said reaction chamber.

CLARENCE E. PECK.